# Understanding and Using Propagation Information

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"What's the band like?" "Are you hearing any DX? The bands are dead." "Can you hear anything?" "Did my antenna fall down?" Do these questions sound familiar? On the high frequencies you'll probably hear them echoed by DX hunters prowling the ssb or CW bands.

Have you wondered how you can tell what the band conditions are without tuning through the phone and CW segments looking for stateside or DX stations that might give a clue as to what's going on? There's an easier way to determine the state of propagation on the high frequency bands.

## Propagation

High frequency communications that cover any distance depend upon skywave signals reflecting off the ionosphere. The state of activity in the several ion layers — the D, E, $F_1$ and $F_2$ layers — determines whether a signal on any given frequency will be reflected to earth.

Propagation forecasts are available in a variety of forms. Long- and short-range forecasts, some detailed and some general, predict the maximum usable frequency (MUF), above which signals will not reflect, and the approximate time of day during which certain areas of the world will be open for signal paths.

This article recaps some of the various sources of information and explains how to use that information.

## Magazines

Propagation forecasts in the various magazines are usually written from 45 to 60 days in advance of the publication date. The forecasts are based on extrapolations of current data on sunspots and other measures of solar activity.

Forecasts can't account for short-run variations of solar activity. Longer-range solar disruptions can loosely be forecast by extrapolating the rule-of-thumb 27-day rotation of the sun. The propagation columns include *Horizons'* "DX Forecaster," *QST's* "How's DX?" charts, and *CQ's* "Propagation."

## Other sources

A biweekly newsletter is available on a subscription basis; it offers detailed propagation forecasts. For further information, write Mail-A-Prop, Box 1714, Silver Spring, Maryland 20902.

Mail-A-Prop also supplies tapes for the recorded telephone Dial-A-Prop: 516-883-6223. Although not a toll-free call, the message is available twenty-four hours a day seven days a week. The message tape is usually changed each Tuesday morning before noon Eastern time.

The Ham Radio Publishing Group publishes the weekly newsletter *HR Report*; propagation information appears on page 4 of each issue. In addition to the useful propagation information, this newsletter covers current news of amateur activities and regulations, new equipment coming on the market, personalities in the news, and DXpedition activities. Once a month an updated calendar of activities is included. See the ad in this issue for additional information.

The American Radio Relay League, through its station W1AW, runs a weekly propagation bulletin in its daily airing of news bulletins and OSCAR schedules. Check a recent copy of *QST* for a current schedule of the phone, CW, or RTTY bulletins.

### WWV geophysical alerts

The problem with even a weekly forecast is that it can't account for daily or hourly variations in solar activity. The closest thing we have available to us is a daily report, with a portion of the message updated every six hours.

WWV, the National Bureau of Standards time and frequency station, broadcasts from a location near Boulder, Colorado, on frequencies of 2.5, 5, 10, 15, and 20 MHz. Among its many services are the geophysical alert messages aired at 18 minutes past the hour, 24 hours a day, 7 days a week.

Unlike the information sources described earlier, which are tailored to the radio amateur, the geophysical alert message is designed for the scientific community at large.

Let's look at a typical message, broadcast at 2018 GMT on July 22, 1978:

> "Solar terrestrial indices for 21 July follow: solar flux 136 and A index 5 . . . repeat . . . solar flux 136 and A index 5. The Boulder K index at 1800 UT on 22 July was 2. Solar terrestrial conditions for the last 24 hours follow: solar activity was moderate to low; the geomagnetic field was quiet. A solar flare occurred at 1857 UT 21 July. Forecast for the next 24 hours follows: solar activity will be low; geomagnetic field will be unsettled to active."

The message is changed each day at 0000 GMT (or, Universal Time). The first part of the message gives the solar flux from Ottawa at 2695 MHz, the A index value at Fredericksburg, Virginia, and the K index value at Boulder. The K index is updated every six hours, at 0000, 0600, 1200, and 1800 GMT. The second part of the message recaps the previous day's solar and geomagnetic activity, and a forecast for the current (GMT) day.

WWV transmits from a site near Boulder, Colorado, on 2.5, 5, 10, and 15 MHz. WWV is the only outlet that transmits the geophysical alert information at 18 minutes past each hour. WWV announces each minute in Universal Time, equivalent to GMT.

**Solar flux:** The solar flux is a measure of the intensity of solar electromagnetic radiation; a number of different frequencies are monitored by the Algonquin Radio Observatory in Ottawa, but 2695 MHz is normally taken as a standard. The solar flux has a range from about 60 to 400 units; there is a positive correlation to the sunspot number. The solar flux is normally a better indicator in the process of predicting MUFs than is the sunspot number.

**A index:** The A index is a measure of geomagnetic activity, ranging from 0 to 400 units. Zero units is extremely quiet and 400 units is very disturbed.

**K index:** The K index is a quasi-logarithmic index of geomagnetic activity ranging from 0 to 9 units. The K indices of the day are averaged to determine the A index for the 24-hour period. The reason why the average K index doesn't equal the A index later aired by WWV is that the former is measured at Boulder, and the latter is taken at Fredericksburg; there is a variation in radiation levels at different places on the earth.

**Table 1** illustrates the relationship between the A and K indices. By comparing yesterday's A index with the current K index, you can see whether the geomagnetic activity is increasing, holding steady, or decreasing. You can also compare activity levels within the same day by noting successive six-hour K indices. The greater the difference of values (either up or down) in a

MONTH/YEAR____________ 19__

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOLAR FLUX | | | | | | | | | | | | | | | | | |
| A-INDEX | | | | | | | | | | | | | | | | | |
| K-INDEX | 0000 Z | | | | | | | | | | | | | | | | |
| | 0600 Z | | | | | | | | | | | | | | | | |
| | 1200 Z | | | | | | | | | | | | | | | | |
| | 1800 Z | | | | | | | | | | | | | | | | |
| FLARE START (Z) | | | | | | | | | | | | | | | | | |

| | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOLAR FLUX | | | | | | | | | | | | | | | | |
| A-INDEX | | | | | | | | | | | | | | | | |
| K-INDEX | 0000 Z | | | | | | | | | | | | | | | |
| | 0600 Z | | | | | | | | | | | | | | | |
| | 1200 Z | | | | | | | | | | | | | | | |
| | 1800 Z | | | | | | | | | | | | | | | |
| FLARE START (Z) | | | | | | | | | | | | | | | | |

| A | K |
|---|---|
| 0 | 0 |
| 3 | 1 |
| 7 | 2 |
| 15 | 3 |
| 27 | 4 |
| 48 | 5 |
| 80 | 6 |
| 140 | 7 |
| 240 | 8 |
| 400 | 9 |

**Fig. 1.** You can use this chart to record WWV radio propagation data on a daily basis. Use the information in the article to plan your DX activities.

short time interval, the more rapidly band conditions will change.

Usually the start of a radio communications disruption is relatively quick in changing conditions from good to bad, whereas the end of a disturbance — the recovery phase — is drawn out over a longer period of time.

Solar activity can be classified as very low; low; moderate; high; and very high. These terms relate to the state of the regions on the solar disk capable of producing disruptive flares. There is a positive correlation between the solar flux and solar activity. The terminology describing geomagnetic activity in terms of K and A indices is listed in **Table 1**.

**Table 1.** Relationship of the A and K indices transmitted by the National Bureau of Standards station WWV.

| K | A | classification (geomagnetic activity) |
|---|---|---|
| 0 | 0 | quiet |
| 1 | 3 | quiet |
| 2 | 7 | quiet |
| 3 | 15 | unsettled |
| 4 | 27 | unsettled-to-minor storm level |
| 5 | 48 | minor storm level |
| 6 | 80 | major storm level |
| 7 | 140 | major storm level |
| 8 | 240 | major storm level |
| 9 | 400 | major storm level |

### The auroral zone

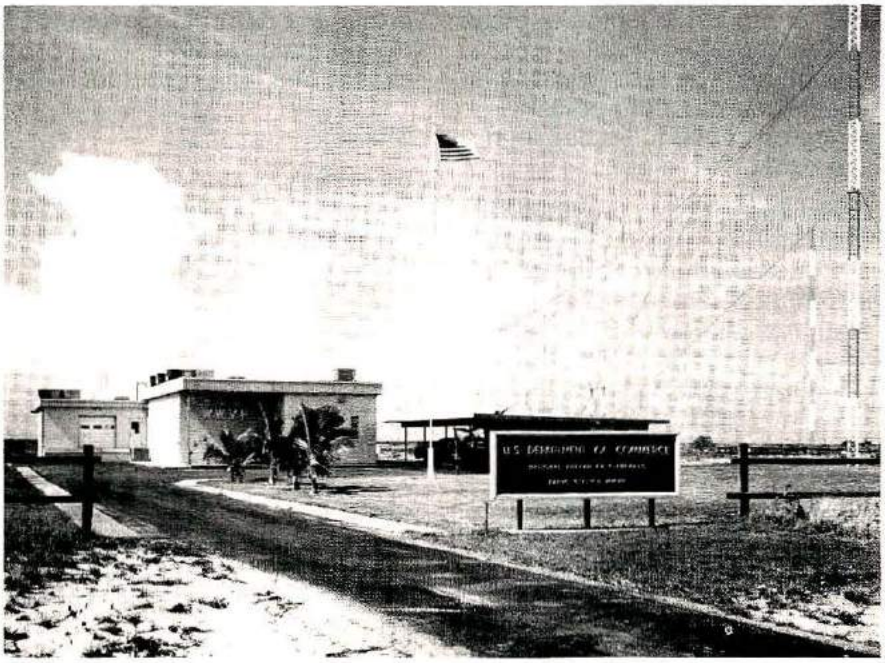
There are ever-present auroral zones over the north and south poles. When geomagnetic activity increases, so does the size of the auroral zones; when it decreases, the size of the auroral zones decreases, but at a slower rate.

If a skywave signal passes through the auroral zone, the signal is usually affected; a characteristic polar flutter is induced upon the signal. Amateurs on the East Coast will note the flutter on JA signals on 15 and 20 meters during East Coast evening hours; West Coast amateurs will notice the same rapid flutter on signals from Europe.

Given enough geomagnetic activity, the signal transversing the zone will not be reflected but will be absorbed. On the East Coast, the high-latitude great-circle path to Japan will be the first affected, then high-latitude paths into northern Europe will disappear. As the intensity of the geomagnetic storm increases, the reflection points of lower-latitude paths will be encompassed by the enlarged auroral zone.

If the geomagnetic storm is severe enough, there can be a total loss of skywave signals from the east, north, and west of the listener's location. Reflection points of skywave signals coming from the south may still be outside the enlarged auroral zone; the signals will seem to be stronger than usual, but this is because of the lack of other interference rather than enhanced propagation.

WWVH, Kauai, Hawaii, also transmits on 2.5, 5, 10, and 15 MHz. No propagation information is transmitted over WWVH, but the female announcer can often be heard on the East Coast as she announces each minute, just ahead of the WWV announcement.



### Using the information

The next step in using the WWV geophysical alert information is to develop a frame of reference for your location and equipment, including antennas. For example, the better your antennas, the longer you can get results despite worsening or marginal propagation conditions. No matter how much power *you* run, if you can't hear 'em, you can't work 'em.

**An example:** Given my location, antenna, and suburban environment, I find a solar flux of 150 is more or less the breaking point for determining if 20 or 15 meters will stay open all night during the summer. A flux of 140 during the quiet winter months means realistic 40-meter CW DX possibilities into JA and VK land at sunrise here (assuming the A index is low).

Similarly, I find that an A count (or its equivalent K index) around 30 takes out all but the Central- and South-American signals. With a flux of 150 and K of 4, I'd expect to find strong signals from the south on 15 and 20 meters.

Characteristically, A counts of 10 to 20 usually mean northern Europeans (F-G-DL-SM-LA) are reduced in strength (JA has long since disappeared when the A index hits 5), and signals coming in on lower-latitude great-circle paths (such as EA-I-YU-UB5) from southern Europe and Russia dominate the high frequency bands during the evening hours.

In analyzing the forecast for July 22 illustrated above, I'd judge that 10 and 15 meters would be closed, and 20 may or may not propagate at night. The previous day's flux was 144, dropping eight points, and the forecasted activity went from moderate to low, dropping the MUF. Although the present absorption levels, with the low MUF, will wipe out paths over the northern Pacific for me, other areas of the world should be reasonable until the effects of the solar flare hit, by late in the GMT day of July 22. I'll probably wind up on 40 CW before the night is over, assuming the atmospheric noise from summer thunderstorms is not too severe.

By the way, it's possible to move too *low* in frequency. With a high flux count or geomagnetic activity, signal absorption of lower frequencies can occur, establishing a lower usable frequency (LUF). Sometimes the term window is used; it can be defined as the range of frequencies between the MUF and the LUF.

**Operating aid:** I've provided the chart in **Fig. 1** for those who are interested in recording the information broadcast by the National Bureau of Standards stations. It is designed for a one-month period. If you enter the data transmitted by WWV or WWVH in the appropriate squares, you'll find the chart quite useful in planning your DX activities, based on the information in this article.

What you'll find at your location, as I said earlier, will depend on your equipment and antennas. For example, during unsettled to minor storm level conditions I've heard good signals coming in from Cuba and Puerto Rico. These amateurs are still working European and Japanese amateurs, because CO and KP4 are farther south; the reflection points along their great-circle paths are at a lower latitude, outside the enlarging auroral zone. Those paths won't be affected until the geomagnetic storm intensifies.

### In conclusion

Just remember that you don't have to be an engineer or an astrophysicist to use the propagation sources detailed above. All but the WWV geophysical alerts are in plain English for the radio amateur, and once you have constructed a set of references you'll be on your way to having one step up on those choosing operating frequencies on a hit or miss basis.

What makes this hobby fun is that there can be exceptions to the rules. Sometimes DX stations will suddenly show up and have very good signals in a short-run aberration in what otherwise seems to be absolutely impossible conditions. An occasional CQ in a seemingly dead band may produce a surprise. Beware of the normal, watch for the exceptions, and have fun.

### Bibliography

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**HRH**

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